DECLASSIFIED
DATE Nov. 7/86
AUTHORIZED BY

MINERALOGICAL INVESTIGATION OF DRILL CORE SAMPLES FROM A Zn-Pb-Ag-Au DEPOSIT OF BILLITON CANADA IN NEW BRUNSWICK

W. Petruk

July 1983

Project MRP-3.3.9.9.99
Cost Recovery in Conservation and Resource Assessment

Job No. 025167

MICROMEDIA

This document is an unedited interim report prepared primarily for circulation and internal communication purposes. It does not represent a final expression of the opinion of the Canada Centre for Mineral and Energy Technology (CANMET)

Ce document est un rapport provisoire non-révisé et rédigé principalement pour fin de dissémination et de documentation interne. Il ne représente nullement l'expression définitive de l'opinion du Centre canadien de la technologie des minéraux et de l'énergie (CANMET)

18pp

MINERALS RESEARCH PROGRAM
MINERAL SCIENCES LABORATORIES
DIVISION REPORT MRP/MSL 83-8 (CR)

CONFIDENTIAL

MINERALOGICAL INVESTIGATION OF DRILL CORE SAMPLES FROM A Zn-Pb-Ag-Au DEPOSIT OF BILLITON CANADA IN NEW BRUNSWICK

by

William Petruk

ABSTRACT

Eighteen samples of drill core from a Zn-Pb-Ag-Au deposit of Billiton Canada Limited in New Brunswick were studied to identify the minerals and to interpret the metallurgical characteristics of the material in the deposit. The samples contain pyrite, arsenopyrite, several antimony-bearing minerals, sphalerite and galena. The silver-bearing minerals are tetrahedrite and native silver. No gold was found. The ore is very fine-grained and the minerals are intimately intergrown; therefore, it will be difficult to produce separate concentrates and to obtain good recoveries. On the other hand, it may be possible to produce a bulk sulphide concentrate with a reasonable metal recovery. No suggestions are proposed for treating such a bulk sulphide concentrate.

A cyanidation test was performed to determine the leachability of the silver and gold. With a 48-hour leach in a solution of 1.25 kg/T NaCN at a pH of about 12, the silver and gold extractions were 34 and 8% respectively. Both silver and gold must occur in refractory minerals.

INTRODUCTION

Eighteen samples of drill core from a Zn-Pb-Ag-Au deposit on a property of Billiton Canada Limited in New Brunswick were received from Mr. J. Salomao, field geologist, in March 1983. Mr. Salomao requested that the minerals be identified in thin and polished sections in order to aid in evaluating the metallurgical characteristics of the deposit. The study was undertaken in the Mineralogy Section, Mineral Processing Laboratory, CANMET as Cost-Recovery Job No. 025167. Polished and polished thin sections were studied, optically, with reflecting and transmission microscopes, and then with a scanning electron microscope.

SAMPLES AND CHEMICAL ANALYSES

The samples received were pieces of drill core up to several cm in length. The sample numbers, depth in drill holes, and chemical assays of 5-foot sections that contained the samples are given in Table 1.

Table 1 - Chemical analyses of samples supplied

Sample no.	D.D.H.	Depth	Assay ppm*						Type of section prepared
			Au	Ag	Cu	Pb	Zn	Sb	
3296									Polished
3297	5	730.5							Polished
3298	3	799							Polished
4301	5	707	0.15	87.7	940	2,320	4,000	-	Polished thin
4302	5	713	0.15	116	1300	3,600	6,800	-	Polished
4303	5	717	0.15	17	164	2,800	5,800	-	Polished thin
4304	5	720	0.15	17	164	2,800	5,800	-	
4305	5	726	1.56	65	75	600	1,500	-	Polished
4306	5	732	2.60	225	60	6,000	15,200	-	Polished
4307	5	530.5	1.50	34.8	54	768	2,700	-	Polished thin
4308	5	534.0	1.50	34.8	54	768	2,700	-	
4309	5	538.5	1.20	104	61	532	1,400	-	Polished thin
4310	5	540.5	1.20	104.5	61	532	1,440	-	Polished
4311	3	793	0.18	25	25	150	2,700	5,000	Polished
4312	3	796	0.04	598	700	4,100	10,000	8,000	Polished
4313	3	798	0.04	598	700	4,100	10,000	8,000	Polished thin
4314	3	801	0.07	159	275	1,400	10,000	1,800	Polished
4315	3	804	0.07	159	275	1,400	10,000	1,800	Polished

*10,000 ppm = 1%: 34.29 ppm = 1 oz/t.

RESULTS

The polished and polished thin sections show that the rock contains disseminated cubic and rounded pyrite and marcasite grains that range from a fraction of a micrometre to about 20 micrometres in diameter (Fig. 1). The pyrite and marcasite are intimately intergrown. In this report no distinction will be made between these minerals and they will referred to collectively as FeS_2. Similarly the rounded grains will be referred to as framboids. Many of the FeS_2 cubic grains and framboids are overgrown with FeS_2 so that some framboids appear to be surrounded by FeS_2 rings (Fig. 2),

and others occur at the cores of larger FeS_2 grains (Fig. 3). In some places the grains are clustered together to form nearly massive FeS_2 with small amounts of sphalerite disseminated in the interstitial non-metallic minerals (Fig. 4).

The massive FeS_2 tends to occur in a clay silicate matrix between fragments of the rock (Fig. 5) and, megascopically, has the appearance of short veinlets. In some places the masses occur along fractures and then they are "true" veins. The interfragment masses and the "true" veins are generally about 1 to 10 mm wide although some are several centimetres wide. In some places the massive FeS_2 is associated with other sulphide minerals and in such cases they are referred to as massive sulphides.

The massive sulphides in Sample 4302 consist of euhedral to anhedral FeS_2 grains and contain small amounts of galena and boulangerite ($Pb_5Sb_4S_{11}$) in the interstices (Fig. 6). Some of the FeS_2 grains have cores that are composed of very minute FeS_2 crystals commonly surrounded by narrow galena layers (Fig. 6). In one place near a zone enriched in interstitial galena and boulangerite three grains of native silver, smaller than 1 μm in diameter, were found in the FeS_2 on a freshly polished surface of the specimen. After the specimen was left in the laboratory atmosphere for two weeks the silver could not be found, apparently it had tarnished and looked like the other pits in the pyrite grain. A second attempt at repolishing did not produce a good enough fresh surface to display the silver.

A 25 mm wide zone of massive sulphides in Sample 3297, was studied. It is composed of masses of FeS_2, masses of arsenopyrite, and masses of sphalerite. The massive FeS_2 contains sphalerite in interstices, and the cores of many FeS_2 grains contain minute FeS_2 crystals and framboids, some surrounded by very narrow galena and tetrahedrite ($(Cu,Ag,Fe)_{12}Sb_4S_{13}$) layers. The FeS_2 is partly replaced by arsenopyrite and in a few places FeS_2 remnants with associated galena and tetrahedrite occur in arsenopyrite (Fig. 7). Most of the arsenopyrite is in masses that are composed of euhedral arsenopyrite grains, and the masses are cut by numerous galena veinlets. The massive sphalerite appears to be intergrown with galena and contains numerous euhedral arsenopyrite crystals and minute chalcopyrite inclusions (exsolutions) (Fig. 8). In addition veinlets 1 to 50 μm wide of jamesonite ($Pb_4FeSb_6S_{14}$), bournonite and rarely tetrahedrite cut across the sphalerite, arsenopyrite and FeS_2 (Fig. 9). In one place

the jamesonite is associated with tetrahedrite (Fig. 10).

A layered vein, about 6 mm wide, in Sample 4306 was studied. This vein has layers of massive FeS_2, arsenopyrite (Fig. 11), sphalerite, galena, and jamesonite-boulangerite. The sphalerite contains small to large (1 to 30 μm) inclusions of galena, numerous minute inclusions (exsolutions) of chalcopyrite (Fig. 12) and very narrow (1 μm wide) veinlets of bournonite and/or tetrahedrite. Some of the galena in sphalerite is intergrown with bournonite and/or tetrahedrite (Fig. 13). The jamesonite-boulongerite layer is near the sphalerite and associated galena. It consists largely of jamesonite but contains some bournonite and galena (Fig. 14).

Samples 3298 and 4314 have veins, up to 5 mm wide, of sphalerite and antimony minerals. The main antimony mineral in Sample 3298 is stibnite (Sb_2S_3) (Fig. 15). Some of the stibnite contains inclusions of arsenopyrite and sphalerite and some is intergrown with bournonite (Fig. 16). The main antimony mineral in the vein in Sample 4314 is jamesonite, but some associated stibnite is present, and some of the jamesonite contains tetrahedrite inclusions (Fig. 17). SEM-EDXA analysis show that the tetrahedrite contains a small amount of silver. Other antimony minerals observed include a minute grain of native antimony disseminated in the silicate minerals in Sample 4315 (Fig. 18) and minute grains of berthierite ($FeSb_2S_4$) in the FeS_2 in Sample 4312 (Fig. 19).

The main silicate minerals identified in the polished thin sections are quartz and feldspar. Minor ones are sericite, chlorite and carbonate minerals. Minerals in trace amounts are apatite, zircon and titanite. in addition some rutile is present in isolated places. The feldspar is generally altered to clay minerals.

CYANIDATION TEST

A cyanidation test was run by G.W. Leigh of the Mineral Dressing Section, MPL to determine the leachability of silver and gold from this ore. Pieces of drill core were sawed from each sample to produce a composite of 250 grams of material. The material was crushed to minus 200 mesh, assayed, and treated with NaCN and CaO at reagent consumption rates of 1.25 kg/t NacN and 3.09 kg/t CaO and a pH of 11.44 to 12.25 for 48 hours. The silver and gold assays of the composite were 71.5 and 1.3 ppm respectively and of the residue 47.5 and 1.2 ppm. The silver and gold

recoveries by cyanidation were, therefore, 33.6 and 7.7% respectively. This indicates that much of the silver and most of the gold is in refractory minerals.

DISCUSSION

The mineralogical study and chemical analyses show that elements which could have economic significance are antimony, zinc, lead, silver and gold. The antimony-bearing minerals are stibnite, jamesonite, bournonite, tetrahedrite, native antimony and berthierite. They are present as veinlets cutting all the minerals in the ore and as minute inclusions in other minerals. The veinlets are so narrow and the inclusions so small that it would be difficult to obtain sufficient liberation, even at a very fine grind, to produce an antimony concentrate with high recovery.

The zinc occurs in separate sphalerite grains. Most of the grains are large enough to be liberated at the normal fine grind that is required for flotation (≈80% minus 325 mesh), but much of the sphalerite contains so many minute inclusions of other minerals that it may be difficult to produce a high grade zinc concentrate and obtain a reasonable zinc recovery. However, the overall contribution of these impurities to the sphalerite has not been determined. It could be much less than this observation suggests because in optical microscopy the observer tends to focus on the unusual phases.

Most of the lead occurs as small galena grains. As with antimony, it would be difficult to obtain a high grade lead concentrate and high lead recovery.

The silver-bearing minerals found in the samples are silver-bearing tetrahedrite and native silver. One grain that has the optical properties of acanthite was observed in Sample 4302. The amount of silver dissolved by a 48-hour cyanidation test was 34%. Since silver and acanthite are completely soluble in a NaCN solution, and since only 10% of the Ag in tetrahedrite is expected to dissolve in the solution, it is interpreted that about 25% of the silver in the ore is in native silver which, in 200 mesh material, is available for reaction with NaCN. The remainder is in tetrahedrite, in other silver-bearing minerals not yet identified, and perhaps in minute grains of silver completely enclosed in FeS_2.

No gold was observed in the polished sections and only 8% of it was recovered by cyanidation. The framboidal nature of the pyrite shows a similarity of this ore to the Carlin gold ores of Nevada, where the gold occurs in pyrite but cannot be found by microscopy nor recovered by cyanidation of the raw ore. Oxidation or roasting of the pyrite is, therefore, required for gold recovery by cyandiation. It is possible that in this ore the gold is also completely enclosed in pyrite and cannot be attacked by the cyanide solution.

The above discussion suggests that some difficulties are to be expected in producing concentrates of separate minerals from this ore. On the other hand it should be relatively easy to produce a bulk sulphide concentrate, but fine grinding would be required. The method of winning the metals from such a bulk concentrate would have to be investigated separately.

ACKNOWLEDGEMENTS

The author thanks G.W. Leigh for performing the cyanidation tests, P.E. Moloughney for the fire assays, Y. Bourgoin and J.M. Beaulne for preparing the polished and thin sections, and N.H. Porphirio, an exchange scientist from Brazil, for analysing several samples with the SEM as part of his training while in Canada.

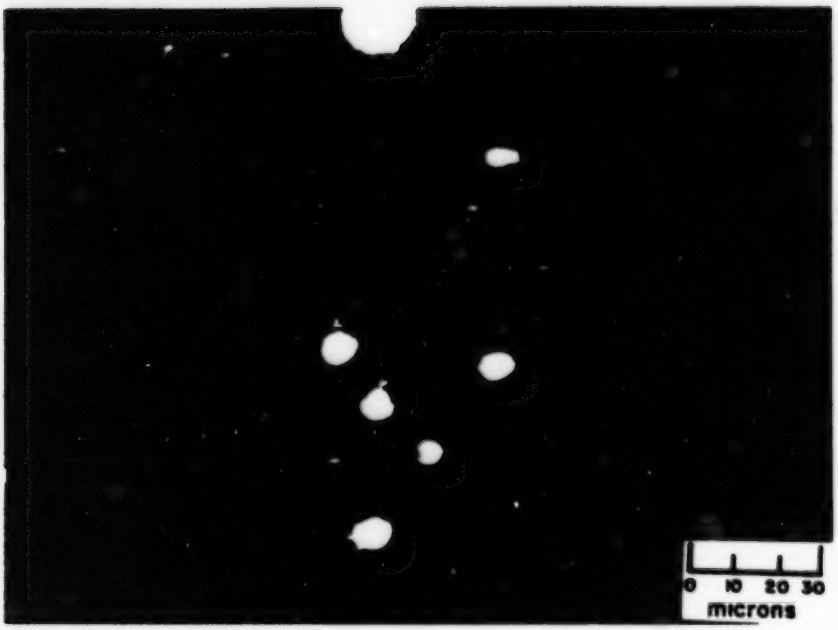

Fig. 1. Photomicrograph of disseminated FeS_2 in wall rock. Sample 4306.

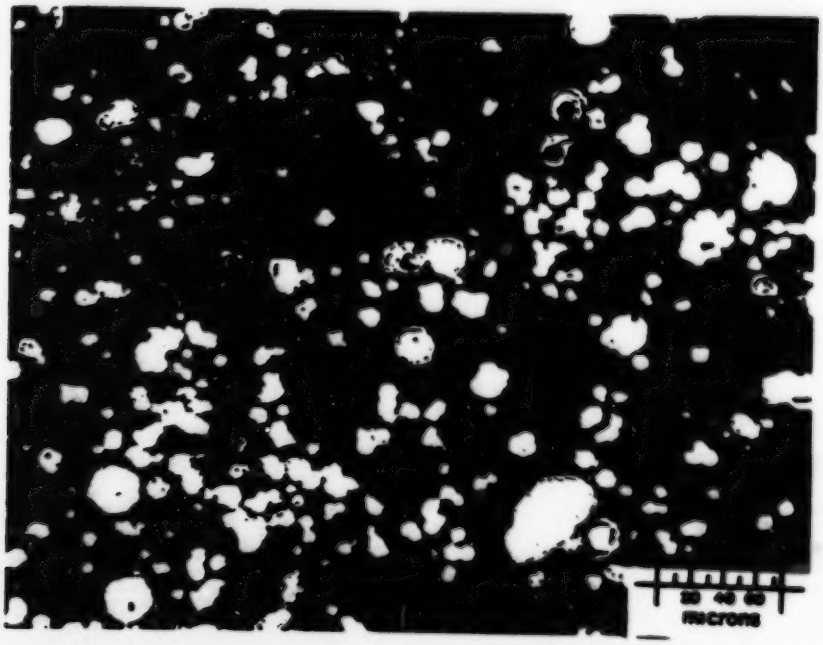

Fig. 2. Photomicrograph of a cluster of FeS_2 framboids (white) with some interstitial sphalerite (grey). Note the overgrowth rings on the framboids. Sample 3296.

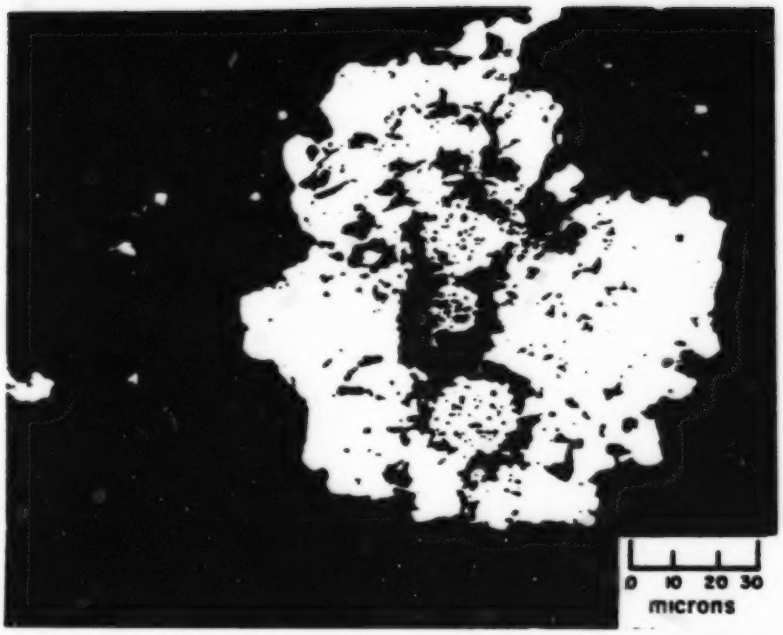

Fig. 3. Photomicrograph of a large FeS_2 grain. The grain contains three pyrite framboids at the core and they are surrounded by marcasite. Some galena is at the framboid-marcasite interface and as inclusions in the marcasite. Sample 4312.

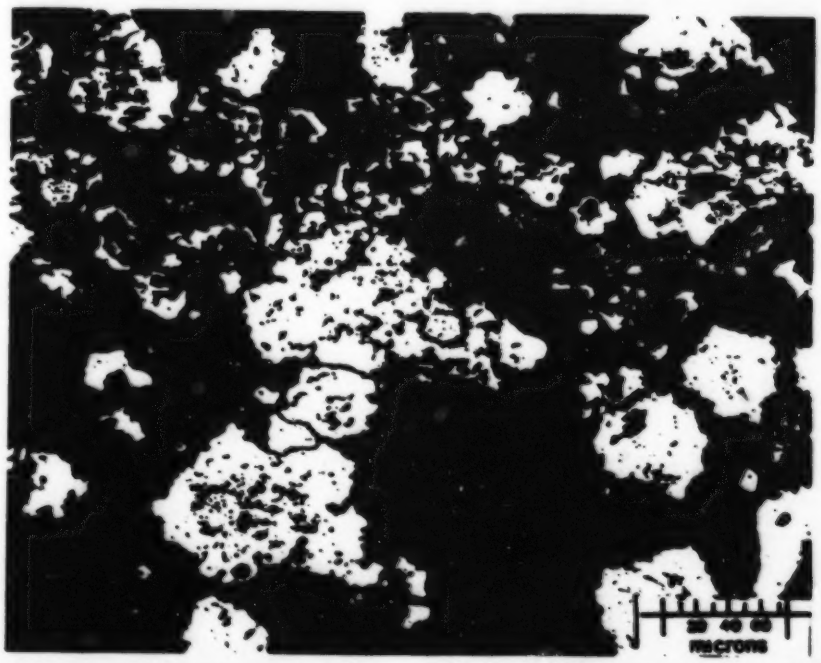

Fig. 4 Photomicrograph of a cluster of large FeS_2 grains. Sample 4312.

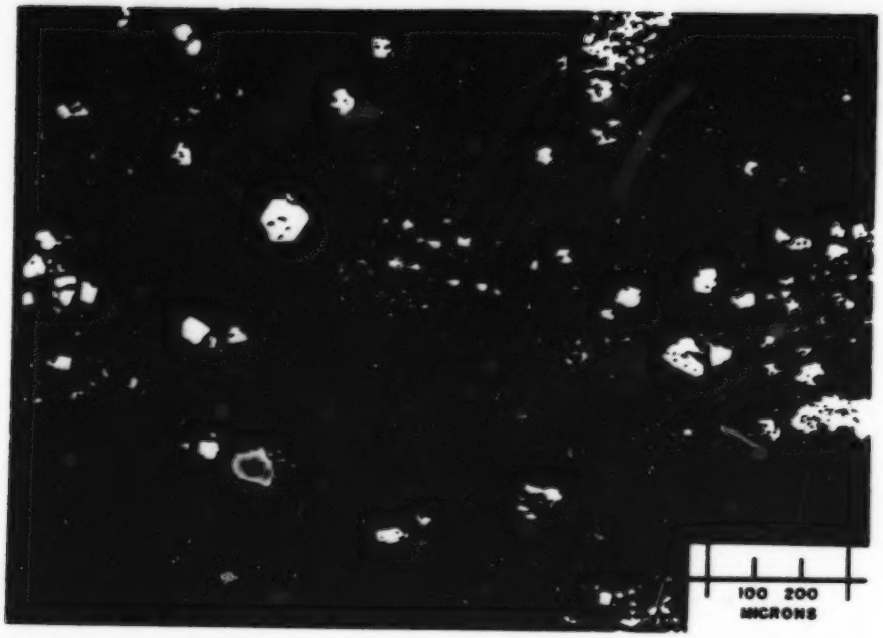

Fig. 5. Photomicrograph of clusters of FeS_2. The clusters tend to occur in the matrix of clay silicates between the rock fragments. Sample 4313.

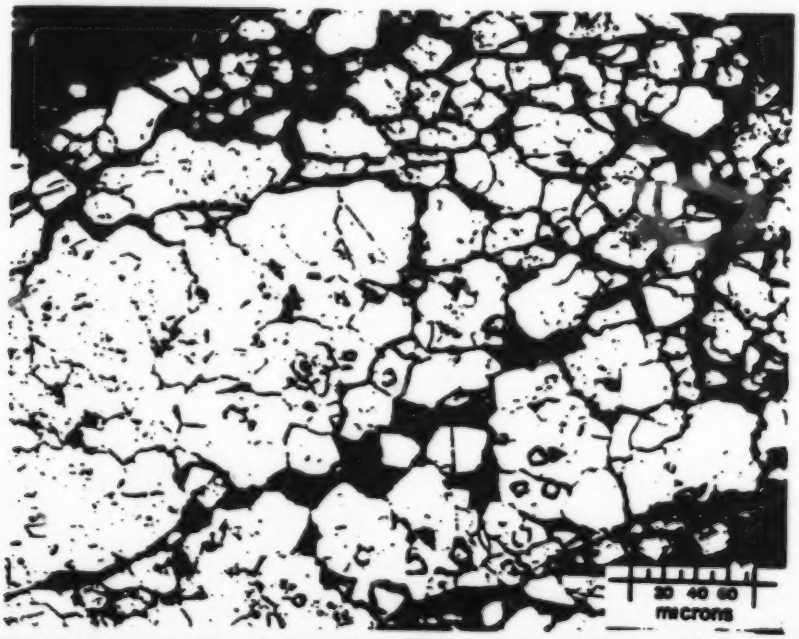

Fig. 6. Photomicrograph of massive FeS_2 with galena and boulangerite (undifferentiated) in interstices. The cores of some FeS_2 contain minute FeS_2 crystals. Some of the crystals are surrounded by narrow galena layers. Sample 4302.

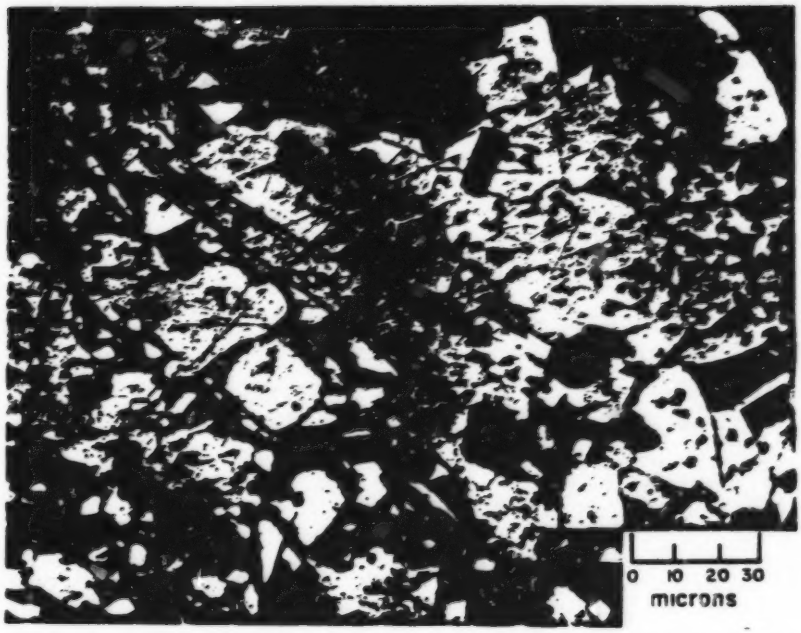

Fig. 7. Photomicrograph of masses of euhedral arsenopyrite with remnants of FeS_2 (outlined in black). The FeS_2 remnants contain minute inclusions of tetrahedrite and galena. Sample 3297.

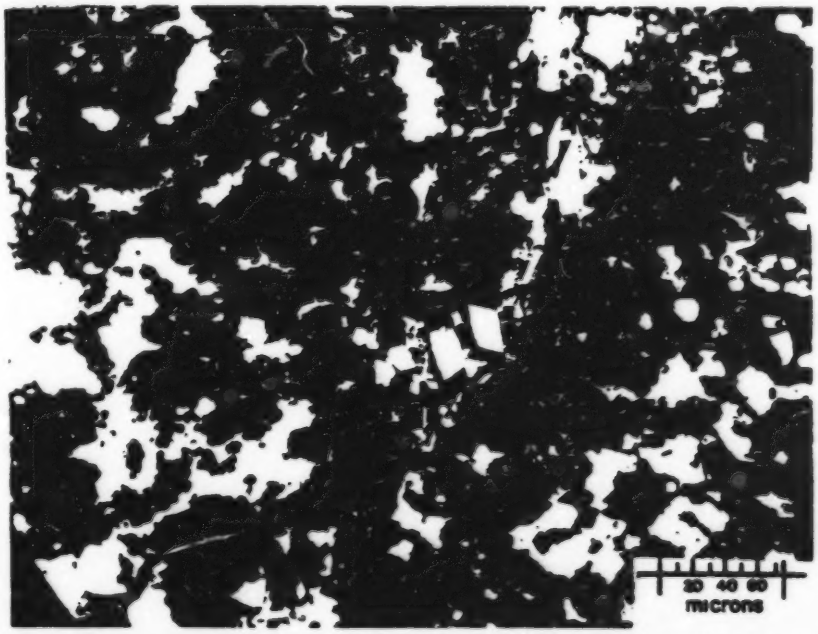

Fig. 8. Photomicrograph of massive sphalerite with inclusions of arsenopyrite (euhedral grains), chalcopyrite (minute grains), galena (G) and jamesonite (J). Sample 3297.

Fig. 9. Photomicrograph of a veinlet of bournonite (grey) cutting across sphalerite (dark grey), arsenopyrite (white) and FeS_2 (very light grey). The medium grey grain at the bottom of the massive arsenopyrite is galena. Sample 3297.

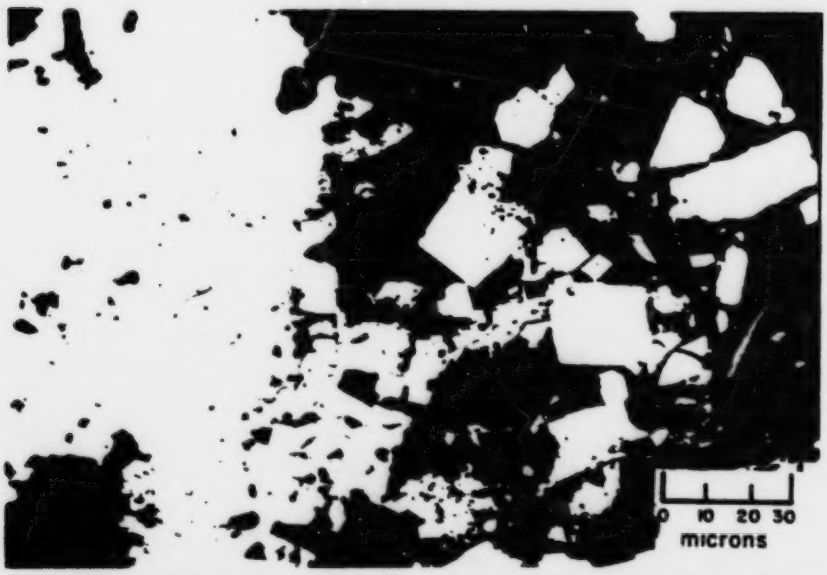

Fig. 10. Photomicrograph of a massive galena (light grey) with euhedral arsenopyrite crystals (white) at left side. Jamesonite (slightly darker grey than galena) is at the centre of photograph. It contains inclusions of tetrahedrite (slightly darker grey than jamesonite). Sample 3297.

Fig. 11. Photomicrograph of an arsenopyrite layer. It contains very large arsenopyrite crystals in a matrix of very fine-grained arsenopyrite. Sample 4306.

Fig. 12. Photomicrograph of sphalerite containing inclusion of galena (large grey grains), chalcopyrite (minute grey grains) and narrow veinlets of bournonite and tetrahedrite. Sample 4306.

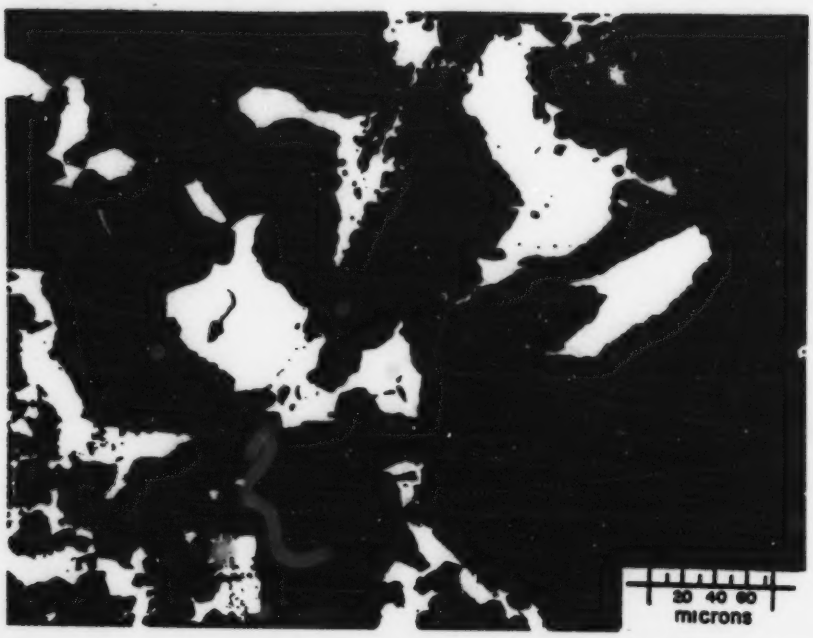

Fig. 13. Photomicrograph of inclusions of bournonite (grey) intergrown with galena (white) in sphalerite (dark grey). Sample 4306.

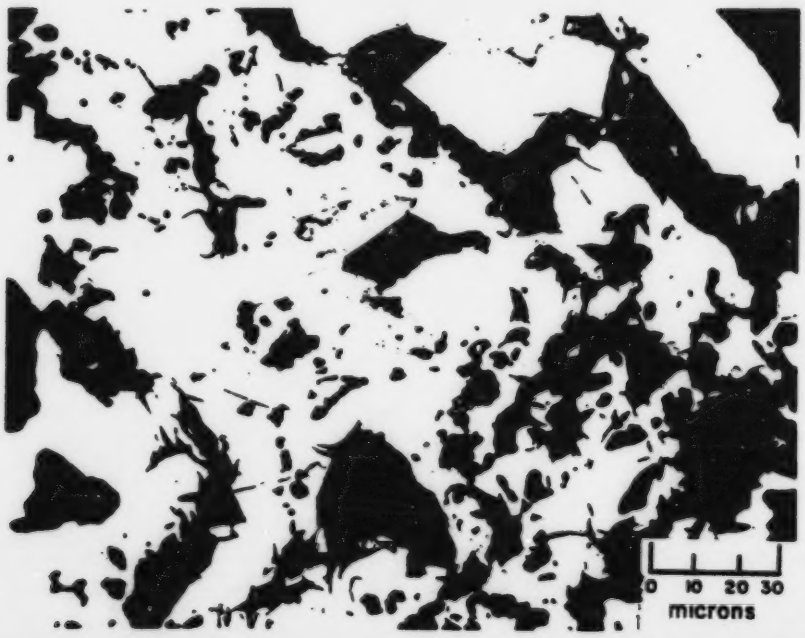

Fig. 14. Photomicrograph of massive jamesonite (grey) with inclusions of bournonite (slightly darker grey than jamesonite), galena (minute off-white grains) and arsenopyrite (euhedral white grains). Sample 4306.

Fig. 15. Photomicrograph of stibnite with inclusions of sphalerite (dark grey) and arsenopyrite (white). Sample 3298.

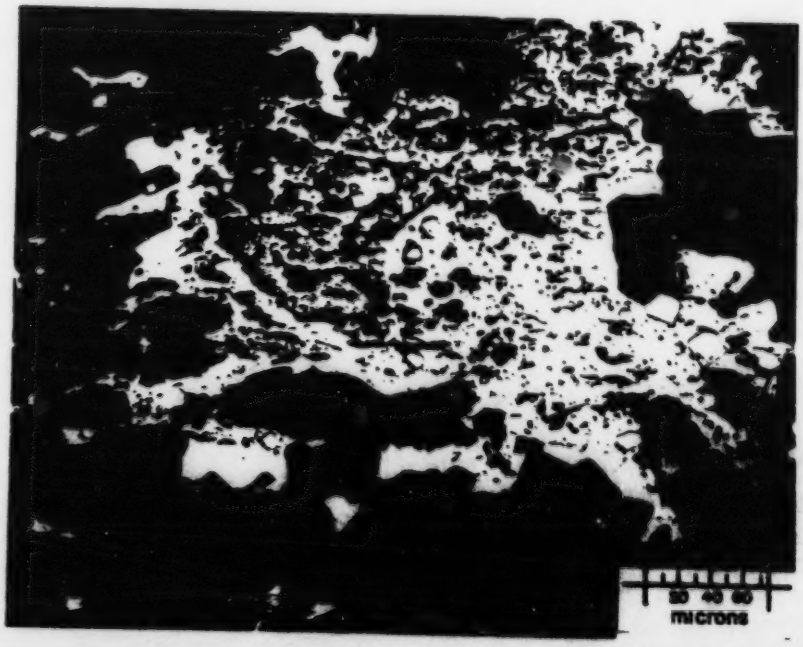

Fig. 16. Photomicrograph of stibnite (light grey) intergrown with bournonite (slightly darker than stibnite) and containing inclusions of arsenopyrite (white). Sample 3298.

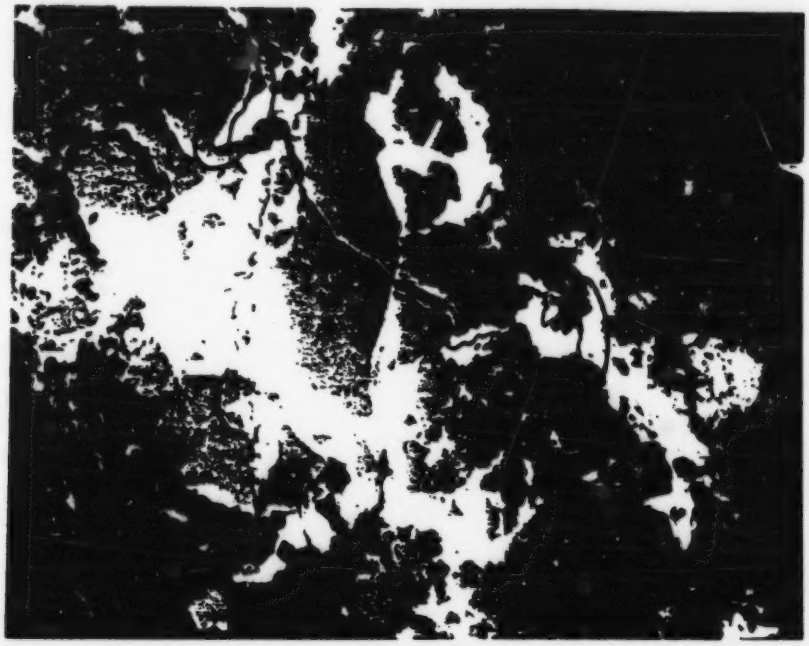

Fig. 17. Scanning electron micrograph (BSE mode) showing a sphalerite vein (dark grey). The vein contains jamesonite (white), some stibnite at edge of jamesonite (speckled white at left side of photograph), and tetrahedrite (medium grey, encircled). Sample 4314.

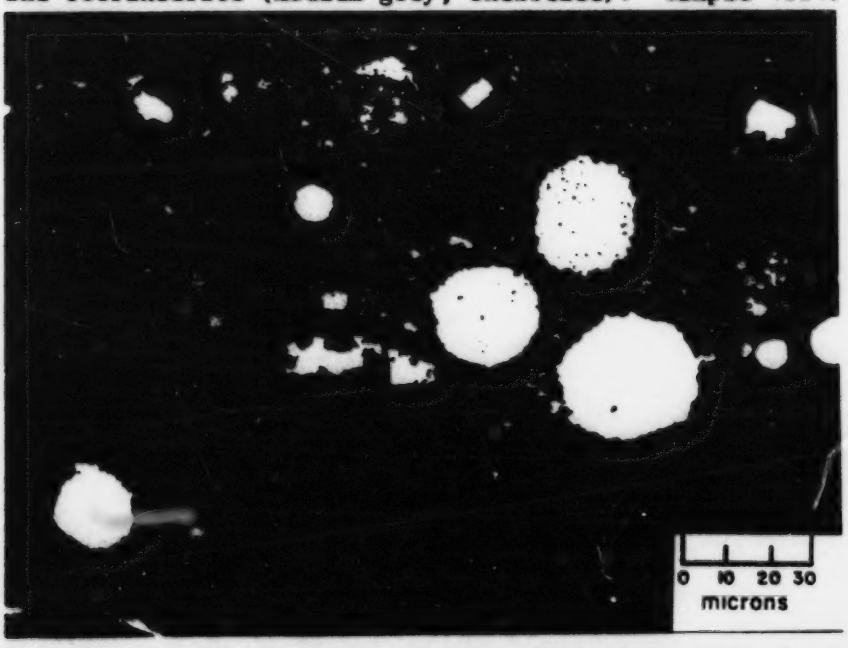

Fig. 18. Photomicrograph of native antimony (white) in silicate matrix. The grey rounded grains are FeS_2. The grey grain to the right of the antimony is bournonite. Sample 4315.

Fig. 19. Scanning electon micrograph (BSE mode) of berthierite (white) in pyrite (grey). Sample 4312.